INTRODUCTION:

The *Telecommunications Act Accessibility Guidelines, Section 1193.43 paragraph (e)* states that *".. the proposed gain of 25 dB is not a problem for current telephone technology. "* and that *"High gain phones without special circuitry currently on the market were tested which put out 90 dB and 105 dB at maximum volume setting. This is a 20 dB gain over the standard 85 dB"* This is in conflict with telephone industry assertions that such a range is not easily achievable without special circuitry.

The complete text of section 1193.43 (e) is attached as Annex A of this report. Also attached as Annex B is the relevant section of the FCC Notice of Proposed Rulemaking released April 20, 1998.

The same three manufacturer's telephone models used as proof-of-achievable in the Access Board guidelines were purchased and tested. The volume controls were tested as well as other related parameters important for safe and reliable operation. The samples are designated Sample "A", Sample "B" and Sample "C" in this report.

Both Sound Pressure Level (**SPL**) at 1 kHz and Receive Objective Loudness Ratings (**ROLR**) were used to determine the volume control range. A discussion of both methods is on page 12.

CONCLUSIONS:

Refer to EVALUATION CRITERIA (page 3) and TEST RESULTS (pages 4-7) for detailed results.

1. Extending the mandatory volume control range to 20 dB or 25 dB should not be justified using these three telephones as a rational.

2. Stability (feedback) is a problem with increased volume. Two of the telephones became unstable ("squealed") when the handset was placed face down on a desktop, or when replacing it on cradle. One unit occasionally became unstable when bringing the handset near the head. The one telephone that did not feedback employed DSP circuitry not found in a typical telephone, had a noise problem and did not have 20 dB gain.

   Stability becomes a bigger problem when manufacturing tolerances are considered. The samples tested had less than nominal transmit level. TIA-470B tolerances allow a 5 dB higher than nominal send level which would directly take away from the stability margin.

3. None of the telephones had a 25 dB volume control range. One telephone had a 23 dB range but started out 6 dB quieter than the specification for a nominal telephone.

4. Two of the telephones require wall-warts (ac supplies) which may be acceptable for a specialized telephone but not for general use telephones.

5. Either Loudness (**ROLR**) or Sound Pressure Level (**SPL**) at 1 kHz may be used to measure the volume control range as long as the shape of the frequency response curve remains constant over the range. If the shape of the frequency response curve changes then ROLR is a more accurate indicator.

   SPL level at 1 kHz is not a good indicator of absolute loudness, however, since it does not account for the frequency response of the handset (i.e., the receiver could have a peak or dip at 1 kHz). In addition, the input circuit and voltage must be specified for the SPL measurement to be usable.

These telephones no doubt are useful to the hearing impaired but should not be the standard for

general use telephones.

DESCRIPTION OF TELEPHONES TESTED:

All three models tested were designed specifically for the hearing-impaired. All models had extra large keys. All had memory dialing. None had speakerphones.

SAMPLE "A"

- This model uses a slide-potentiometer volume control.
- A "Tone" control allows the frequency response of the received voice to be changed. Testing was done using the middle position of this control.
- There is also an "Outgoing Voice Volume" switch — the instruction book states that when activated the transmit level is increased by 15 dB.

SAMPLE "B"

- This design uses a 4 band Graphic Equalizer for a volume control. The bands are centered on 600,1200,1800 and 2400 Hz. Each band has a labeled gain range of 0 to +20 dB.
- An "EQUALIZER" button enables the equalizer. The equalizer is reset to "OFF" after each call.
- Equalization, and probably acoustic echo control, are accomplished using Digital Signal Processing functions. The **DSP** implementation does not allow sine wave signals to pass to the receiver. DTMF tones, clearly heard at the receiver in the unamplified mode, are reduced to chirps, clicks and pops when the equalizer is used. Testing requires the use of special voice-like test signals. A **pulsed pink** test signal, similar to that commonly used for speakerphone testing, was used when the equalizer was enabled.

SAMPLE "C"

- This telephone uses a slide potentiometer for the volume control.
- In addition there is a "Clarity" switch which, when activated, causes the receive signal to have a rising response starting around 300 Hz.

EVALUATION CRITERIA:

The following criteria were used to judge the tested units.

The telephones must pass the following requirements:

1. The telephones must have 20 dB gain delta between default volume and maximum volume.
2. The telephone must remain stable (no feedback or echo) when placed on a desk or brought near the face. A common test is to place the handset face down on a flat surface.
3. An external power supply is not allowed.
4. The Receive and Send Loudness (ROLR, TOLR) should be within the tolerances of TIA-470B.

The following are desirable features:

5. Receive Noise should meet telephone industry requirements at default volume.
6. The telephone should return to its unamplified state when returning on-hook so as not to hurt the

ears of a normal-hearing person.

TEST RESULTS:

Using the criteria above, none of the telephones met requirements.

SAMPLE "A"

- The handset was unstable and "squealed" when placed face down on the desk.
- Requires an external AC supply.

SAMPLE "B"

- This telephone is stable (no "squealing").
- Did not quite meet the 20 dB criteria (is 18-19 dB).
- Is very noisy.
- Requires an external AC supply.
- Employs Special Circuitry that does not allow sine wave tones to pass when the volume control (equalizer) is active. This includes DTMF tones and dial tone. TDD and modem tones probably will not pass but this was not tested. Tones are received when the equalizer is turned off. See **Figure 11**.

SAMPLE "C"

- The handset "squeals" when placed face-down on a table. Sometimes it also squeals when bringing the handset near the ear. The owner's manual states: *" In addition, the high performance of this Clarity Power Control may cause the handset to "squeal" or produce feedback if the handset is set down on a hard surface during the course of a phone call."*

- This sample was 6 dB quieter than a nominal telephone when the volume control was set in its minimum position. If this is typical of all units then the actual volume control range would be effectively be reduced by 6 dB compared to the other models tested. Although this telephone had the widest volume control range it was 4 to 5 dB quieter than the other telephones at the maximum position.

- The volume control does not reset between calls. The owner's manual states: *"**Important**: Reset the Clarity Power Control to zero after every call to protect other users of the telephone"*

- This is the only telephone that does not require an external power supply.

Test results are summarized on the following page (Figure 1 and 2)

PARAMETER	SAMPLE "A"	SAMPLE "B"	SAMPLE "C"
At least 20 dB volume control?	YES	NO (18-19 dB)	YES (Note 1)
Stable at Maximum Volume?	NO	YES	NO
Works without External Power Supply?	NO	NO	YES
Meets Receive Loudness Requirement? (Set to minimum volume)	YES	YES	NO (6 dB quiet)
Meets Transmit Loudness Requirement? (TOLR)	YES	YES	YES
Meets Noise requirements at default?	NO	NO	YES
Volume Control Resets when placed back on-hook?	YES	YES	NO
Employs conventional circuitry?	?	NO (DSP)	?

Figure 1:
Comparison of Tested Units

Note 1. Sample "C" is 6 dB quieter than nominal at the minimum volume control.

PARAMETER	SAMPLE "A"	SAMPLE "B"	SAMPLE "C"
Noise at Minimum < 40 dB SPL (A)	41.4	46.7	31.0
Noise at Maximum (No Spec.) dB SPL (A)	64.1	69.1	56.6
Transmit Loudness (TOLR) -48 +8, -5 dB	-45.6	-46.6	-44.1
ROLR Loudness at Minimum +46 ± 5 dB	42.3	43.5	52.0
ROLR Loudness at Maximum dB	22.9	25.2	28.5
SPL Level at Minimum dB SPL (1 kHz)	95.5	96.9	87.7
SPL Level at Maximum dB SPL (1 kHz)	116.2	115.7	111.5
Volume Control Range Calculated using **ROLR** Proposed > 20 dB	19.4	18.3	23.5
Volume Control Range Calculated using **SPL** Proposed > 20 dB	20.7	18.8	23.9

Figure 2:
Summary of Measurements

Note: Since ROLR and TOLR are calculated using losses the more negative the ROLR or TOLR the louder the telephone.

SAMPLE "A" Volume Control Range

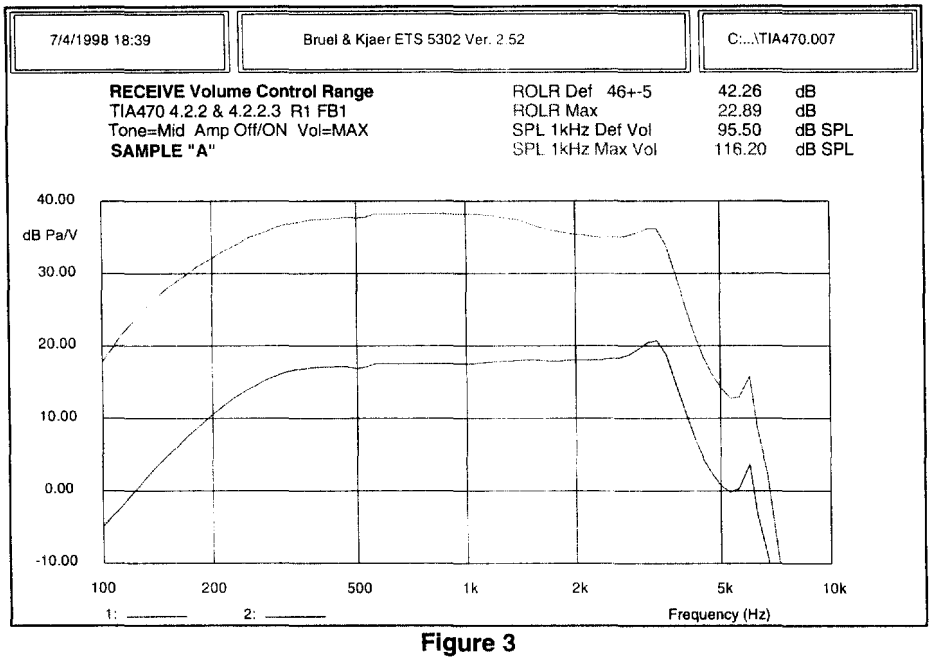

Figure 3
SAMPLE "A" Volume Control Range

SAMPLE "B" Volume Control Range

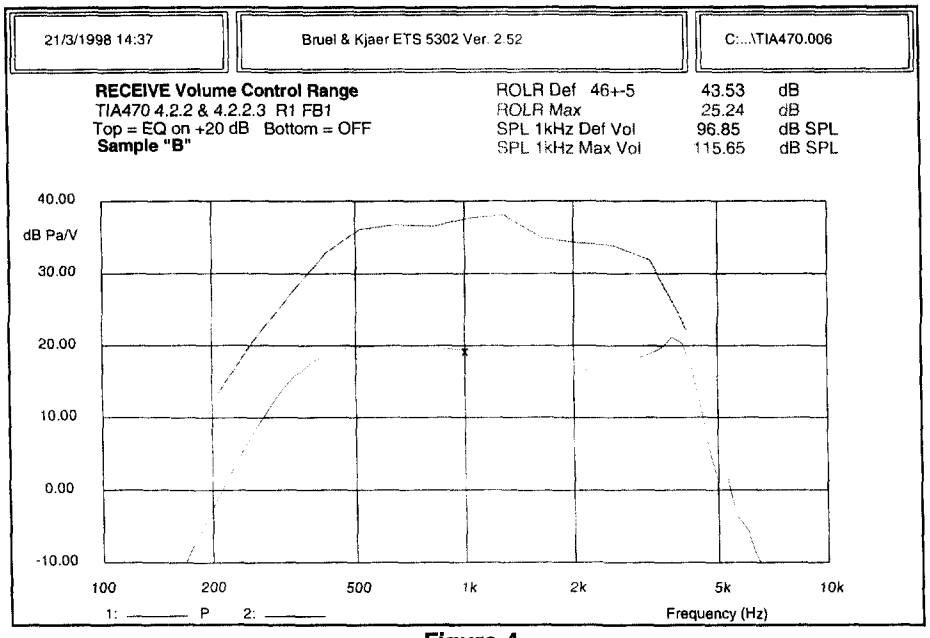

Figure 4
Top - All equalizers set to +20 dB (Maximum)
Bottom - Equalizer OFF (Default Volume)

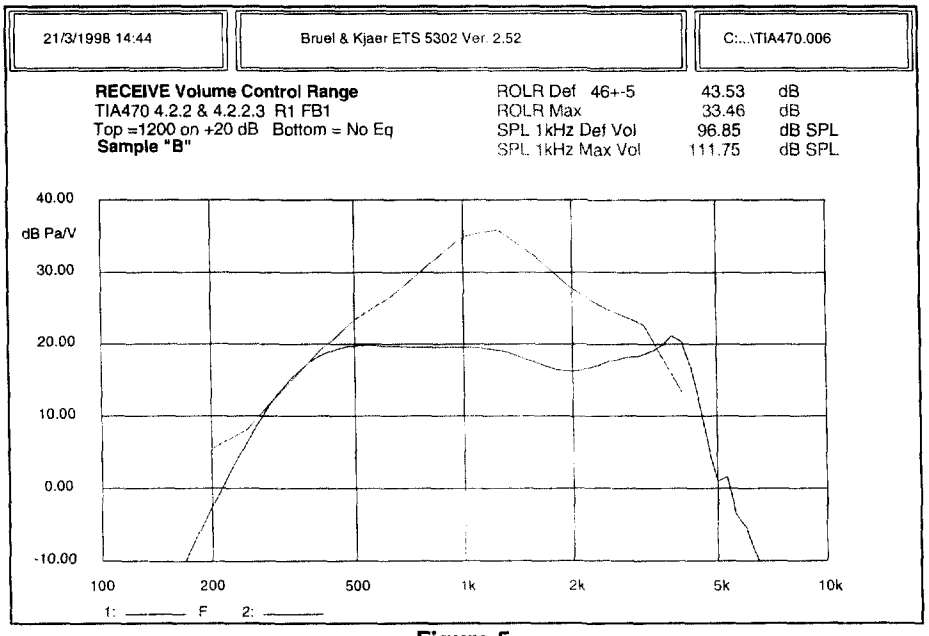

Figure 5
Top - 1200 Hz Band Only set to +20 dB
Bottom - Equalizer OFF

SAMPLE "C" Volume Control Range

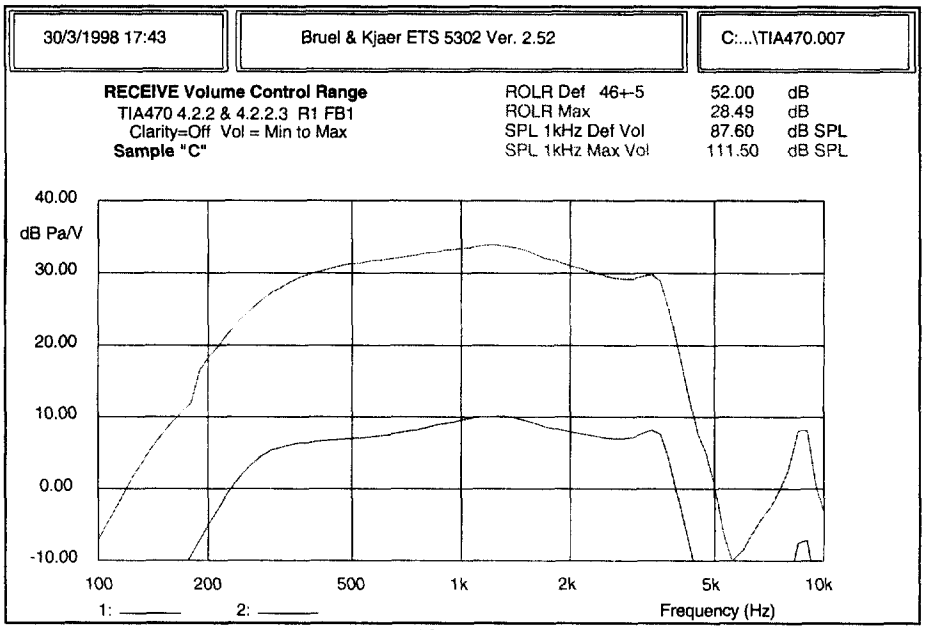

Figure 6
Note: "Clarity" Switch set to "OFF"

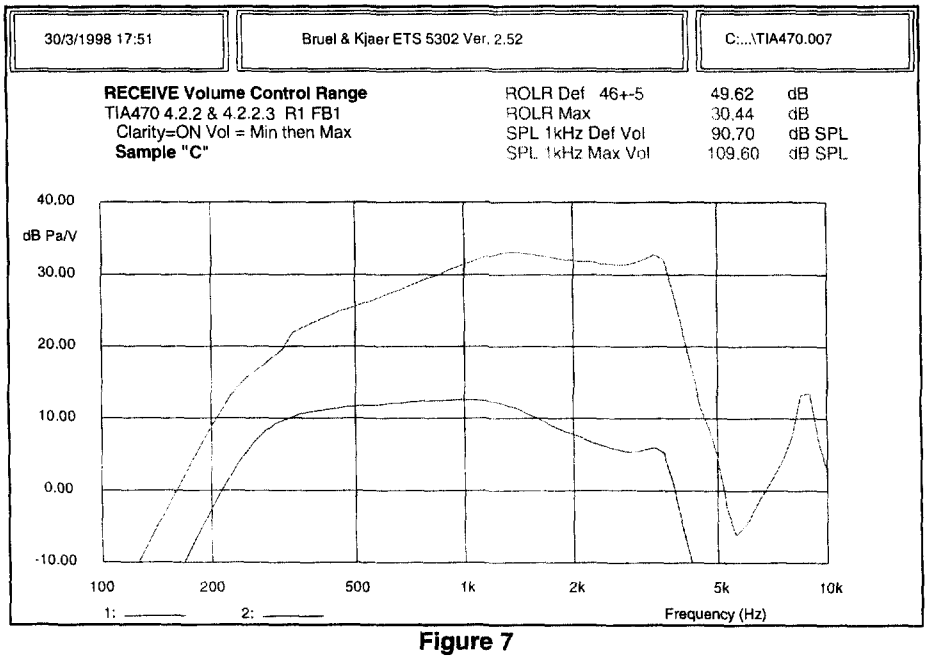

Figure 7
Note: "Clarity" Switch set to "ON"

SAMPLE "A" Unamplified Receive and Transmit

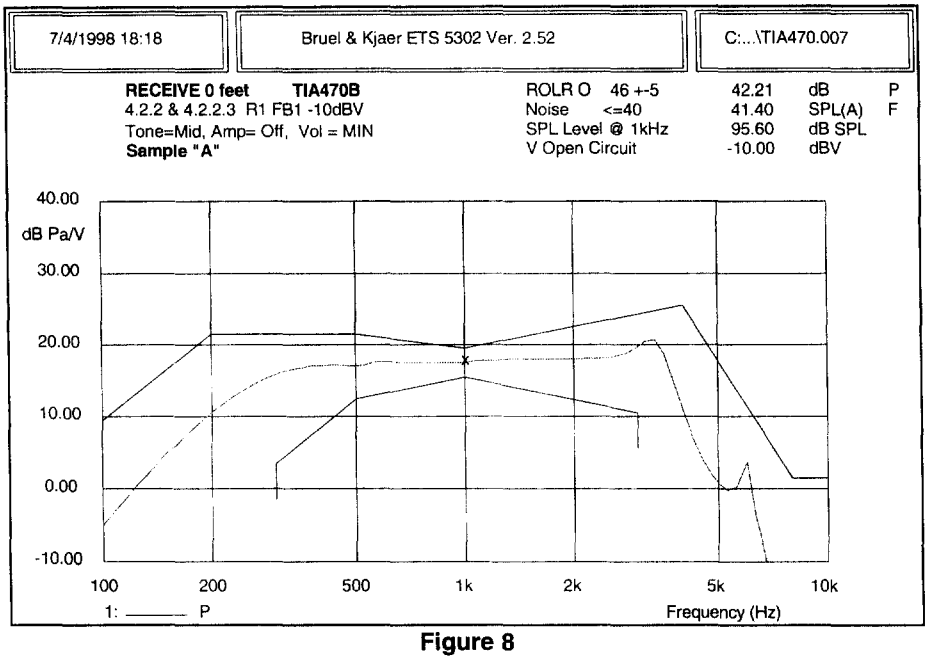

Figure 8
Receive

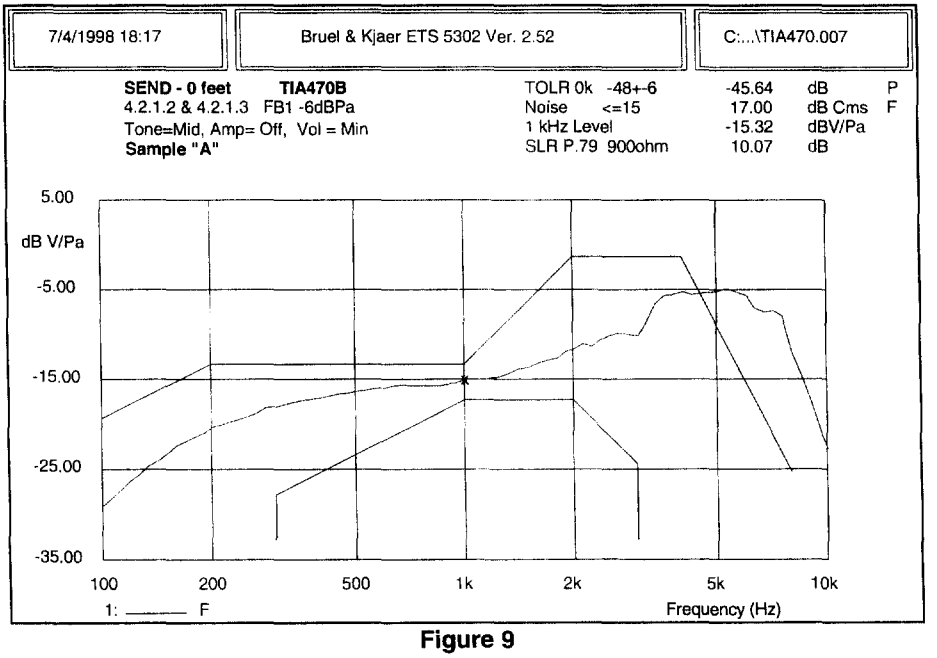

Figure 9
Transmit

SAMPLE "B" Unamplified Receive and Transmit

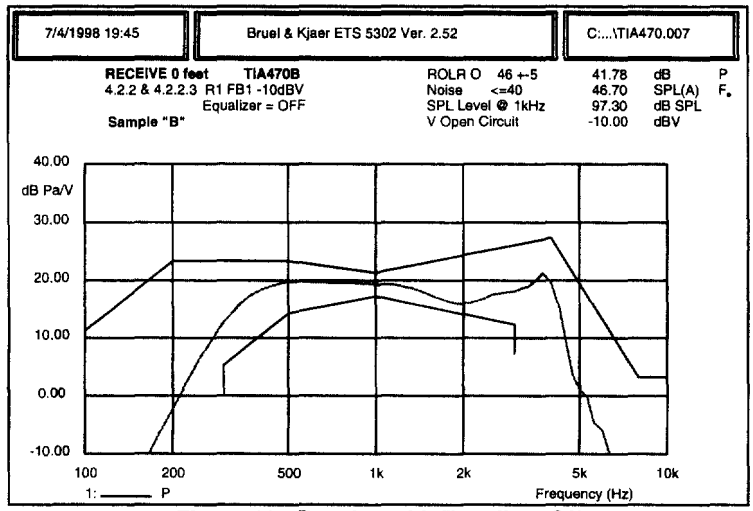

Figure 10 - Receive with Equalizer Off

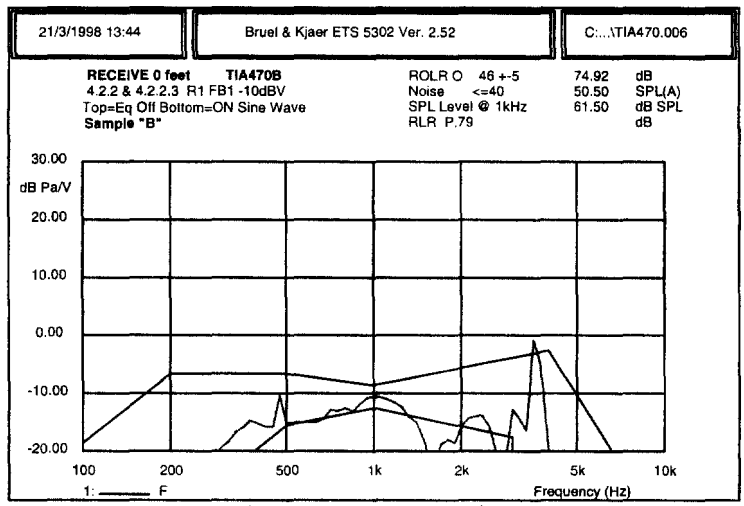

Figure 11 - Equalizer On
Showing Non-Response to Sine Wave Signal when Equalizer is Active

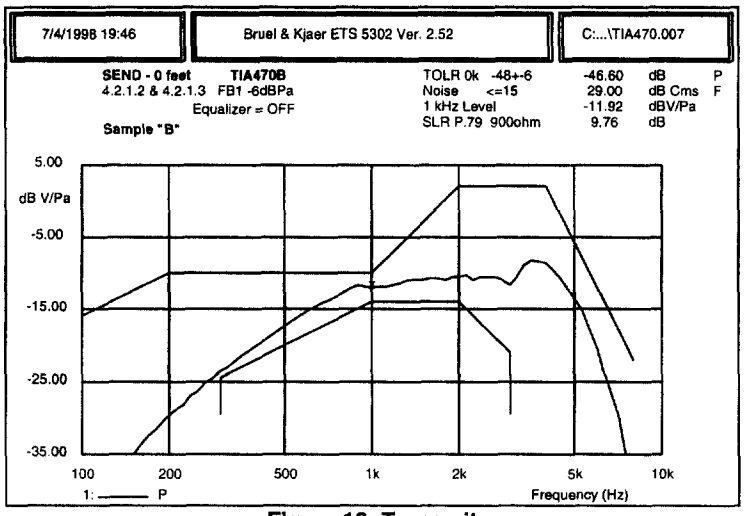

Figure 12 -Transmit

SAMPLE "C" Unamplified Receive and Transmit

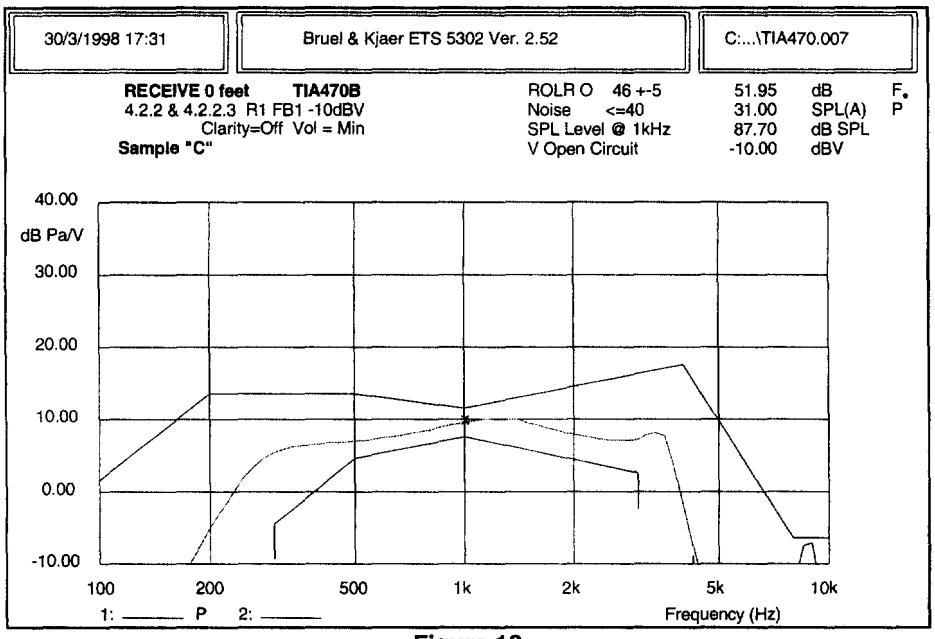

Figure 13
Receive

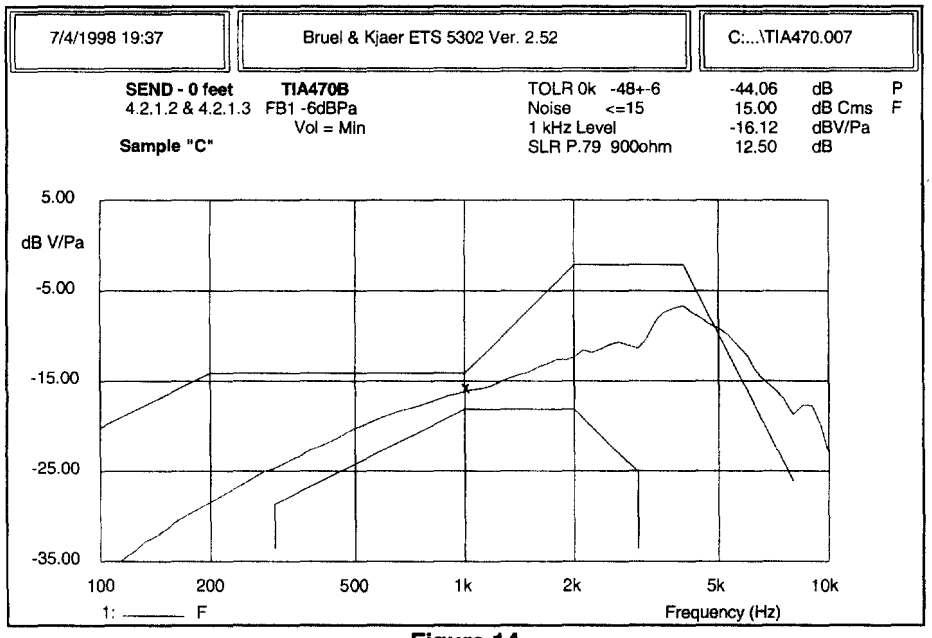

Figure 14
Transmit

TEST SETUP:

The telephones were measured per TIA-470B, 1997. The drive level was -10 dBV (open circuit) from a 900 ohm source. The receive frequency response was measured using an IEC-318 ear coupler and a 1/2 inch pressure microphone (B&K 4192). All test equipment is manufactured and calibrated by Bruel and Kjaer.

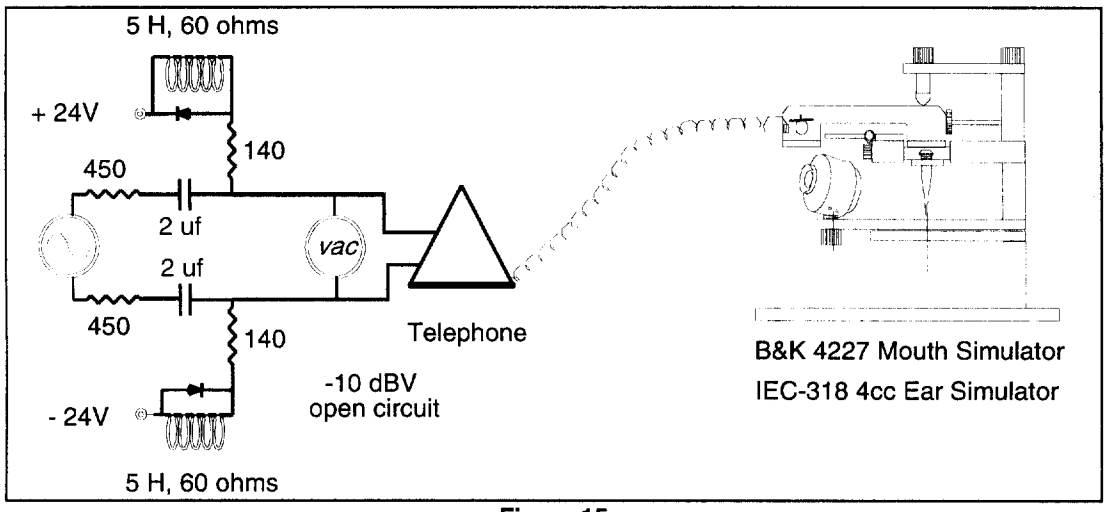

Figure 15
Test Circuit

ROLR and SPL:

One source of confusion is the difference between Sound Pressure Level (**SPL**) and Receive Objective Loudness Rating (**ROLR)** in determining how loud a telephone is.

ROLR is calculated according to IEEE-661, from the frequency response data between 300 to 3300 Hz. The response is the ratio of the sound pressure, in Pascals, to the voltage measured across a 900 ohm calibration resistor in place of the telephone. Since the voltage is divided in half the voltage used in the calculation is 6 dB less than the open circuit voltage. The actual voltage across the telephone under test will be different depending on its impedance.

ROLR is calculated using losses therefore the more positive the ROLR the quieter it is. For example 40 is louder than 50.

If the telephone is linear the drive level does not effect the receive loudness. For example, a drive level of -10 dBV open circuit will produce the same ROLR as a - 20 or -30 dBV level since a reduction in voltage causes an equal drop in sound pressure and therefore the ratio of sound pressure to input voltage remains constant.

SPL, however, is dependent on the drive level. When driven with a -10 dBV open circuit voltage, as shown in **Figure 15** the nominal sound pressure at 1 kHz is 94 dB SPL measured in the artificial ear. If the drive level is changed the SPL changes therefore it is meaningless to state a SPL level without the corresponding drive level. The long term average SPL on local calls is around 84 dB SPL (I didn't confirm

this).

A 1 dB louder ROLR will result in a 1 dB increased SPL unless the shape of the frequency response curve changes. **Figure 5** illustrates a scenario where the frequency response curve does change. In this case the volume control range is 10 dB using ROLR (43.5 - 33.5) but is 14.9 dB using SPL as an indicator (111.8 dB - 96.9 dB).

ANNEX A

Text from:

ARCHITECTURAL AND TRANSPORTATION BARRIERS COMPLIANCE BOARD, *Telecommunications Act Accessibility Guidelines*
Published in the Federal Register February 3, 1998.
http://www.access-board.gov/rules/telfinal.htm

Section 1193.43 Output, display, and control functions [1193.37 in the NPRM]

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Paragraph (e) Availability of auditory information for people who are hard of hearing

Comment. The majority of comments from persons who are hard of hearing reported having trouble using public pay telephones because of inadequate receiver amplification levels. These commenters supported the proposed provision that products be equipped with volume control that provides an adjustable amplification ranging from 18-25 dB of gain. However, TIA and several manufacturers cited the National Technology Transfer and Advancement Act of 1996, which requires the Federal government to make use of technical specifications and practices established by private, voluntary standards-setting bodies wherever possible. Furthermore, TIA claimed that the higher range will result in signals encroaching on the acoustic shock limits of telephone receiver output. TIA recommended that this section be revised to reflect a general performance standard, similar to the recommendation in the TAAC report. Some comments pointed out that there was no baseline signal against which the gain is to be measured. That is, for a weak signal even 18-25 dB of gain may be ineffective, while for a strong signal, the present ADAAG and FCC requirement of 12-18 dB may be sufficient. Also, industry commenters said that increasing gain may not be the only, or even the best way to provide better access since amplifying a noisy signal also amplifies the noise.

Response. Information submitted by SHHH indicates that the proposed gain of 25 dB is not a problem for current telephone technology. The information was based on testing conducted by two independent laboratories (Harry Teder Ph.D., Consulting in Hearing Technology and Harry Levitt, Ph.D., Director, Rehabilitation Engineering and Research Center on Hearing Enhancement and Assistive Devices, Lexington Center). High gain phones without special circuitry currently on the market were tested which put out 90 dB and 105 dB at maximum volume setting. This is a 20 dB gain over the standard 85 dB. The sound was clear with no distortion. SHHH said that this shows that a 90 dB and 105 dB clean speech level is achieved with phones commercially available with no worse distortion levels than on public phones at normal levels. With special circuits and transducers, telephones could generate even higher

amplification levels, above 25 dB, without distortion.

The current FCC standard for 12-18 dB of gain was adopted from ADAAG which requires certain public pay telephones to provide a gain of 12-18 dB. However, this provision is frequently incorrectly applied so that the gain only falls somewhere within this range but does not reach the 18 dB level. In fact, the requirement is to provide gain for the entire range of 12-18 dB.

The Board is currently reviewing all of its ADAAG provisions and will be issuing a NPRM in 1998 which will propose a new ADAAG. The changes to ADAAG will be based on recommendations of the Board's ADAAG Review Advisory Committee. That Committee recommended increasing the gain for public pay telephones from 12-18 dB to 12-20 dB. Recently, the ANSI A117.1 Committee released its 1997 "Accessible and Usable Buildings and Facilities" standard. This voluntary standard-setting body issues accessibility standards used by the nations model building codes. The ANSI standard requires certain public pay telephones to provide 12 dB of gain minimum and up to 20 dB maximum and that an automatic reset be provided. The 1997 ANSI A117.1 document and the Board's new ADAAG are being harmonized to minimize differences between the two documents.

Therefore, in accordance with the National Technology Transfer and Advancement Act, the final rule has been changed to adopt the provision as currently specified in the private, voluntary ANSI standard, with wording to clarify its meaning. For example, the ANSI provision was written under the assumption of an incremental, stepped volume control. If a volume adjustment is provided that allows a user to set the level anywhere from 0 to the upper requirement of 20 dB, there is no need to specify a lower limit. If a stepped volume control is provided, one of the intermediate levels must provide 12 dB of gain. Although the final rule does not provide the higher 25 dB level as proposed in the NPRM, the Board intends to highlight this provision for evaluation in its market monitoring report. If the Board's market monitoring report shows that persons with hearing impairments continue to report having trouble using telephones because the level of amplification is not high enough, the
Board will re-evaluate this provision.

Recently, the FCC issued an order 5 postponing until January 1, 2000, the date by which all telephones covered by Part 68 must be equipped with a volume control. This order was issued as a response to a request for reconsideration asking that the requirement only be applied to new equipment. That request was denied but the time for compliance was extended to take into account its application to telephones already registered under Part 68.

The guidelines only apply to telecommunications equipment and customer premises equipment designed, developed and fabricated after [insert date 30 days after publication]. Therefore, the guideline provision does not conflict with the FCC order. New telephones will be covered by these guidelines and existing telephones will have until January 1, 2000, to comply with the FCC Order.

ANNEX B

The following two pages are text from the title page and the section off the FCC NPR dealing with the volume control.

Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, D.C.

In the Matter of	)	
	)	
Implementation of Section 255 of the	)	
Telecommunications Act of 1996	)	
	)	WT Docket No. 96-198
Access to Telecommunications Services,	)	
Telecommunications Equipment, and	)	
Customer Premises Equipment	)	
by Persons with Disabilities	)	

NOTICE OF PROPOSED RULEMAKING

Adopted: April 2, 1998 Released: April 20, 1998

Comment Date: **June 30, 1998**
Reply Comment Date: **August 14, 1998**

By the Commission: Commissioners Furchgott-Roth, Powell and Tristani issuing separate statements.

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.Sec. 1193.43 Output, display, and control functions.

All information necessary to operate and use the product, including but not limited to, text, static or dynamic images, icons, labels, sounds, or incidental operating cues, shall comply with each of the following, assessed independently:

(a) AVAILABILITY OF VISUAL INFORMATION Provide visual information through at least one mode in auditory form.

(b) AVAILABILITY OF VISUAL INFORMATION FOR LOW VISION USERS Provide visual information through at least one mode to users with visual acuity between 20/70 and 20/200 without relying on audio.

(c) ACCESS TO MOVING TEXT. Provide moving text in at least one static presentation mode at the option of the user.

(d) AVAILABILITY OF AUDITORY INFORMATION Provide auditory information through at least one mode in visual form and, where appropriate, in tactile form.

(e) AVAILABILITY OF AUDITORY INFORMATION FOR PEOPLE WHO ARE HARD OF HEARING Provide audio or acoustic information, including any auditory feedback tones that are important for the use of the product, through at least one mode in enhanced auditory fashion (i.e., increased amplification, increased signal-to-noise ratio, or combination). For transmitted voice signals, provide a gain adjustable up to a minimum of 20 dB. For incremental volume control, provide at least one intermediate step of 12 dB of gain.

(f) PREVENTION OF VISUALLY-INDUCED SEIZURES. Visual displays and indicators shall minimize visual flicker that might induce seizures in people with photosensitive epilepsy.

(g) AVAILABILITY OF AUDIO CUTOFF. Where a product delivers audio output through an external speaker, provide an industry standard connector for headphones or personal listening devices (e.g., phone-like handset or earcup) which cuts off the speaker(s) when used.

(h) NON-INTERFERENCE WITH HEARING TECHNOLOGIES Reduce interference to hearing technologies (including hearing aids, cochlear implants, and assistive listening devices) to the lowest possible level that allows a user to utilize the product.

(i) HEARING AID COUPLING. Where a product delivers output by an audio transducer which is normally held up to the ear, provide a means for effective wireless coupling to hearing aids.

Subpart D — Requirements for Compatibility With Peripheral Devices and Specialized Customer Premises Equipment

Sec. 1193.51 Compatibility.

When required by subpart B of this part, telecommunications equipment and customer premises equipment shall be compatible with peripheral devices and specialized customer premises equipment commonly used by individuals with disabilities to achieve accessibility, and shall comply with the following provisions, as applicable:

(a) EXTERNAL ELECTRONIC ACCESS TO ALL INFORMATION AND CONTROL MECHANISMS Information needed for the operation of products (including output, alerts, icons, on-line help, and documentation) shall be available in a standard electronic text format on a cross-industry standard port and all input to and control of a product shall allow for real time operation by electronic text input into a cross-industry standard external port and in cross-industry standard format. The cross-industry standard port shall not require manipulation of a

connector by the user.

(b) CONNECTION POINT FOR EXTERNAL AUDIO PROCESSING DEVICES Products providing auditory output shall provide the auditory signal at a standard signal level through an industry standard connector.

(c) COMPATIBILITY OF CONTROLS WITH PROSTHETICS Touchscreen and touch-operated controls shall be operable without requiring body contact or close body proximity.

(d) TTY CONNECTABILITY. Products which provide a function allowing voice communication and which do not themselves provide a TTY functionality shall provide a standard non-acoustic connection point for TTYs. It shall also be possible for the user to easily turn any microphone on and off to allow the user to intermix speech with TTY use.

(e) TTY SIGNAL COMPATIBILITY. Products, including those providing voice communication functionality, shall support use of all cross-manufacturer non-proprietary standard signals used by TTYs.